

MODELING ASSUMPTIONS FOR EVALUATION OF UPPER NEW BEDFORD HARBOR CAD CELL

This work is an extension of similar modeling work that has already been completed by ERDC on a proposed CAD cell in the lower harbor (Schroeder et al 2010). Sediments in the upper harbor are more contaminated than those in the lower harbor and water depths are shallower, necessitating additional evaluations for a potential upper harbor CAD cell (UHCC) shown in Figures 1 and 2. The work to be conducted will involve confirming CAD cell size/capacity, consolidation modeling, open water placement/surge modeling, hydrodynamic modeling, loss during disposal modeling, project scale loss modeling, and long-term cap breakthrough.

An estimated 352,000 cubic yards of sediment will be placed into the UHCC. The basis of this estimate is shown below. Note this estimate assumes that MUs 25-37 would be placed in the LHCC, and the vegetated MUs would be disposed off-site:

| | |
|------------------------------------|---------------------------------------|
| MUs 1-24, 102-105: | 532,885 cy (FWEC, 2003) |
| 10% additional for cleanup passes: | 53,289 cy (conservative approach) |
| Subtotal: | 586,174 cy |
| Less dredged through 2010: | - 184,370 cy |
| Assumed dredging 2011 and 2012: | - 50,000 cy (i.e, ROD Amendment 2013) |
| Total: | 351,804 cy |

The sediment properties and bulk contaminant concentrations are reported in Table 1 for all of the MUs. Modeling scenarios will evaluate both 10-year placement and 5-year placement schedules (given in Table 2) to evaluate a range of potential budget possibilities. Disposal will proceed from the more contaminated MUs to less contaminated MUs.

Modeling scenarios will include a UHCC enclosed by sheet pile walls and a second alternative where only a silt curtain enclosure is used. The CAD cell with its containment features is shown in Figure 3, showing a 200-ft opening for barge entry. The CAD cells originally evaluated by Apex Companies had a 650' x 830' surface footprint and a maximum depth 52 feet deeper than the surrounding harbor floor, which has an average depth of 4 ft MLLW (Apex and Jacobs 2006). The originally proposed volume exceeds the storage volume required after the 2012 dredging is completed; therefore, a 570' x 740' surface footprint for the CAD cell was used in the modeling as shown in Figure 3. Side slopes for the top eight feet of the CAD cell were set at 1V:6H to provide stability for the organic surface sediments and for the remaining 44 ft of depth the side slopes were set at 1V:3H for the glacial till and decomposed/fractured rock. Disposal into the CAD cell will be based on placement in 150 to 200 cubic yard increments from a split hull, bottom dump barges with a capacity of about 150-200 cubic yards barge with a draft of six feet and a hopper 60 feet long. Two to four barge dumps per day is assumed. The barges are assumed to contain about 15% captured water and 85% sediment by volume. The dredged

material is assumed to entrain additional water during placement from the descent through the water column and the collapse and spreading of the material on the bottom.

The contaminant partitioning data will be based on the partitioning findings for the 2009 ERDC sediment composites 1 through 3 reported in the Lower Harbor CAD Cell report (Schroeder et al. May 2010). Likewise the consolidation data will be based on the consolidation findings for the 2009 ERDC sediment composites 1 through 3 provided by Jacobs Engineering (2009) and analyzed in the Lower Harbor CAD Cell report (Schroeder et al. May 2010).

Modeling will be performed using the same approaches and models as in the evaluation of the Lower Harbor CAD Cell (Schroeder et al. May 2010). The CAD cell is filled during each dredging season with mechanically dredged and placed material and then left idle between dredging seasons. After the last of the materials from MUs to be placed in the Upper Harbor CAD Cell is placed, the CAD cell is then left idle until the next construction season when the CAD cell is capped with unwashed sand, maintaining the content of fine-grained and organic material. Negligible new deposition on top of the CAD material from outside the CAD cell via bottom load or suspended load is assumed between dredging seasons. Similarly, negligible erosion or resuspension of bed sediments or cap materials from the CAD cell is assumed. A limited exchange of CAD cell water is assumed between dredging seasons.

During filling, dredged material will be stripped and resuspended from the discharge, releasing both particulates with their associated contaminants and pore water with its dissolved contaminants. The pore water will also contain dissolved organic carbon (DOC) and contaminants associated with the DOC. Facilitated transport of contaminants is not specifically assumed, but the partitioning coefficients developed from the SBLT and pore water analysis include the partitioning associated with the DOC as being part of the dissolved contaminants. The particulates, while suspended, partition their contaminants with the CAD cell water. The suspended particulates slowly flocculate and then settle in the CAD cell, leaving the dissolved contaminants and DOC to accumulate in the CAD cell water. However, new particulates are introduced into the water column two to four times per day during the placement season, creating a near steady suspended solids concentration that increases slowly throughout the season and then decreases in the week or two following cessation of placement operations.

The currents in the CAD cell below the top few feet are assumed to be too low to transport particulates to the surface or to resuspend bedded material. Releases from bedded dredged material are limited to pore water expulsion and diffusion. Bioturbation is assumed only in the long-term evaluation after capping. Water and contaminant exchange are assumed in the upper few feet of the CAD cell water by turbulent mixing and by displacement during material placement. After material placement operations cease for the dredging/construction season, diffusion of contaminants from the lower water column to the upper water column of the CAD cell is assumed to occur.

For consolidation modeling purposes, the material placed in a placement season is represented as a single lift at the end of the placement season. The volume of the lift and its void ratio are estimated based on the placement operation and the characteristics of the sediment composite, incorporating the entrainment and densification that occurs during the placement season. The lift

is assumed to contain the entire mass of sediment particles dredged, i.e. there were no losses of particulates.

After placement is completed and the dredged material and suspended solids have been allowed to settle and densify, a cap will be placed to close the CAD facility. The required cap thickness is dependent on the cap design objectives, accounting for bioturbation, consolidation, erosion, and operational considerations. For the purposes of this evaluation, the cap thickness was set to be 3 feet. Unwashed, natural sand was chosen for the capping material, which would typically have a small fraction of organic carbon and fines that would improve the retardation of contaminants in the cap as modeled for the Lower Harbor CAD Cell (Schroeder et al. May 2010).

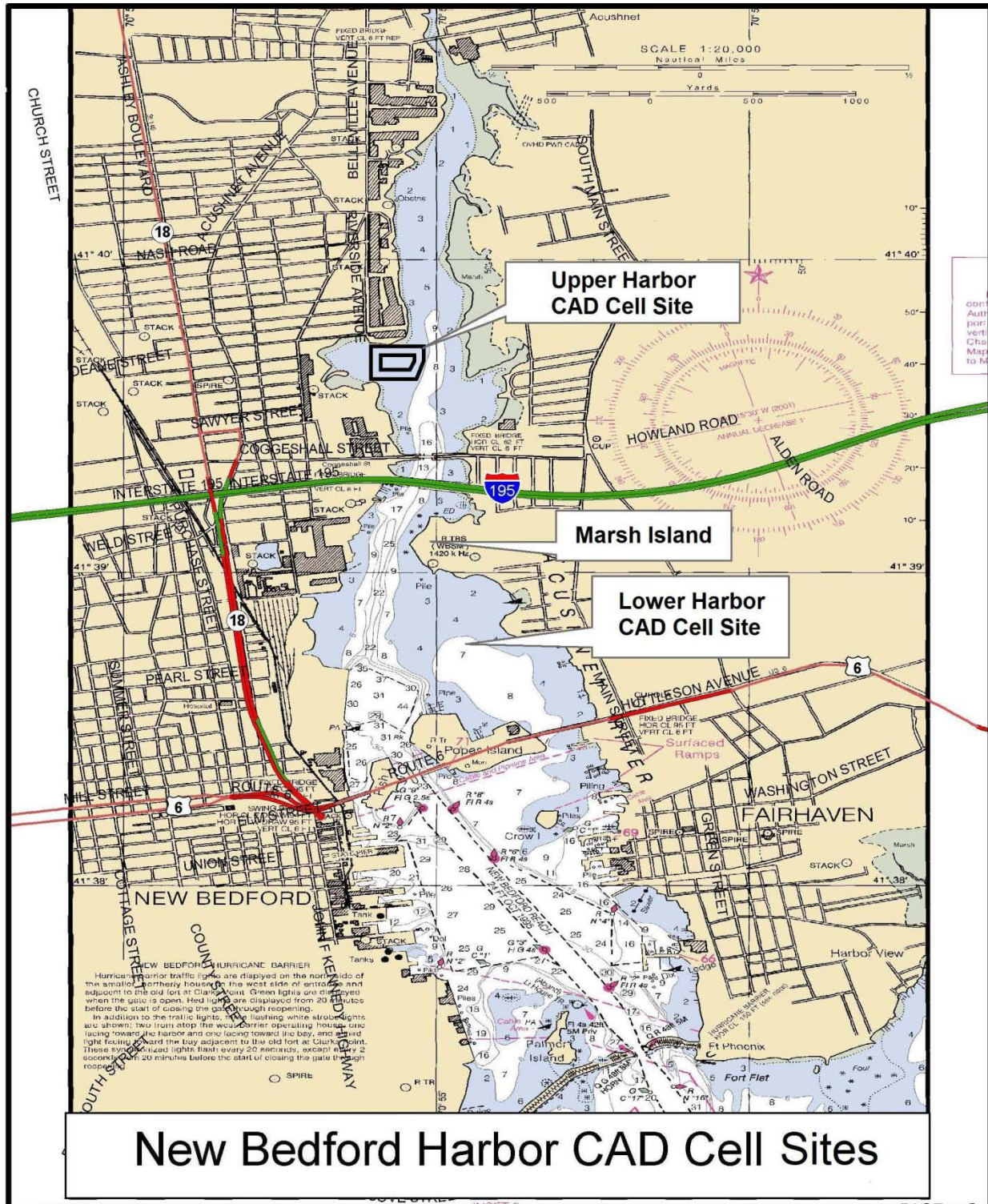


Figure 1. New Bedford Harbor CAD Cell Sites.

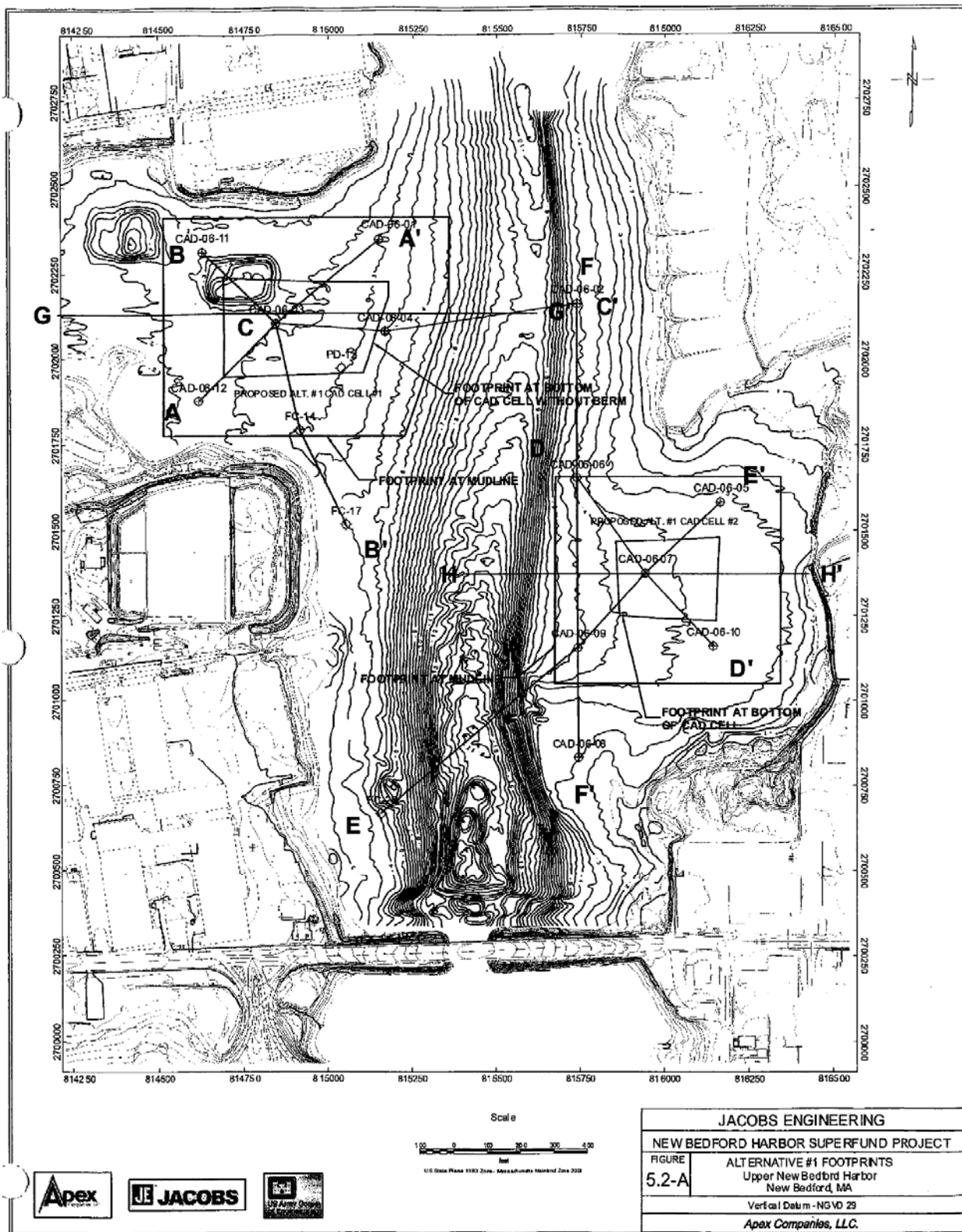


Figure 2. Conceptual NBH CAD Cell Locations Evaluated in 2006.

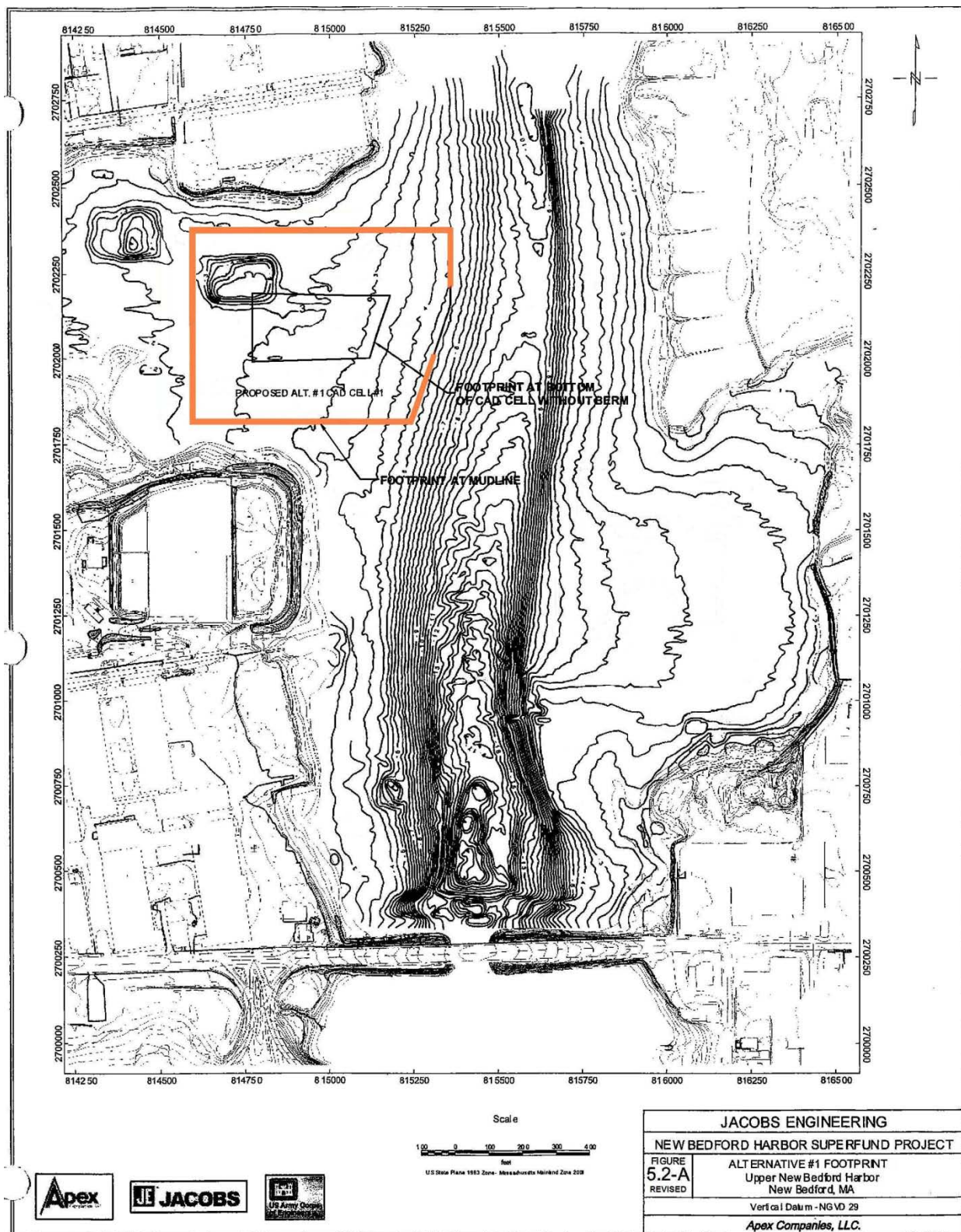


Figure 3. New Bedford Harbor Upper CAD Cell Containment.

Table 5.2-A
Alternative #1 CAD Cell Layout

| Volume Estimates | CAD cell 1 (cy) | CAD cell 1 with Berm (cy) | CAD cell 2 (cy) |
|---|------------------------|--------------------------------------|------------------------|
| Disposal Volume: | | | |
| Base Condition: glacial till, decomposed and fractured rock, bedrock remain in place ¹ | 421,777 | 284,735 | 327,953 |
| Volume of Excavated Organics | | | |
| Contaminated organic material | 70,424 | 70,424 | 49,564 |
| Non-contaminated organic material | 61,528 | 61,528 | 107,154 |
| Total volume organic material | 132,008 | 132,008 | 156,718 |
| Volume of Excavated Glaciofluvial Material | 421,777 | 199,698 | 327,953 |
| Cap Volume | 58,330 | 36,860 | 48,470 |

| Alternative #1 CAD Cell Geometry and Assumptions | CAD cell 1 (cy) | CAD cell 1 with Berm (cy) | CAD cell 2 (cy) |
|---|------------------------|--------------------------------------|------------------------|
| Plan dimensions at mudline (approx.) | see plan | see plan | 700 ft x 700 ft |
| Depth of contamination below mudline | 4 ft | 4 ft | 3 ft |
| Cut slope in organics | 6H:1V | 6H:1V | 6H:1V |
| Cut slope in glaciofluvial deposits | 3H:1V | 3H:1V | 3H:1V |
| Cap thickness | 3 ft | 3 ft | 3 ft |
| Average elevation top of cap | -7.5 | -2.5 | -10.5 |

Notes:

1. Base Condition refers to complete excavation of glaciofluvial material from within the CAD cells. Glacial till, decomposed/weathered, and fractured rock, and bedrock are not excavated in this case (they remain in place).
 2. Berm case includes berm built on glaciofluvial surface to extend cap elevation. Top of berm is at elevation -4.5, crest width 4 ft, berm sideslopes 4H:1V.
- ft = feet, cy=cubic yards

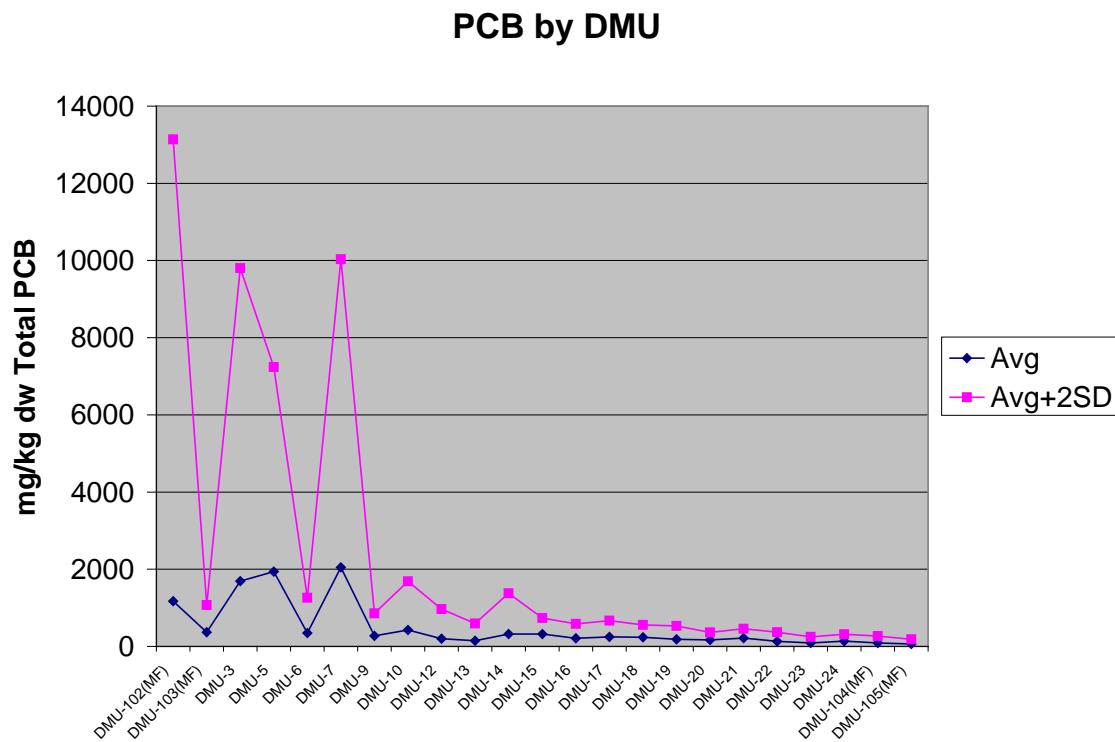


Figure 5. Total PCB Data by DMU.

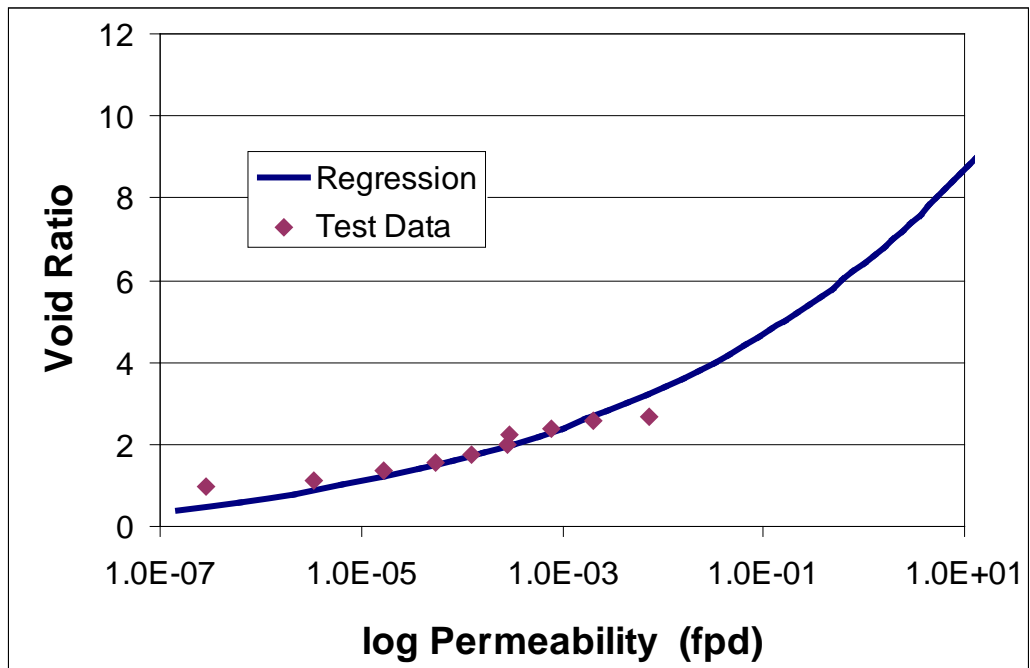
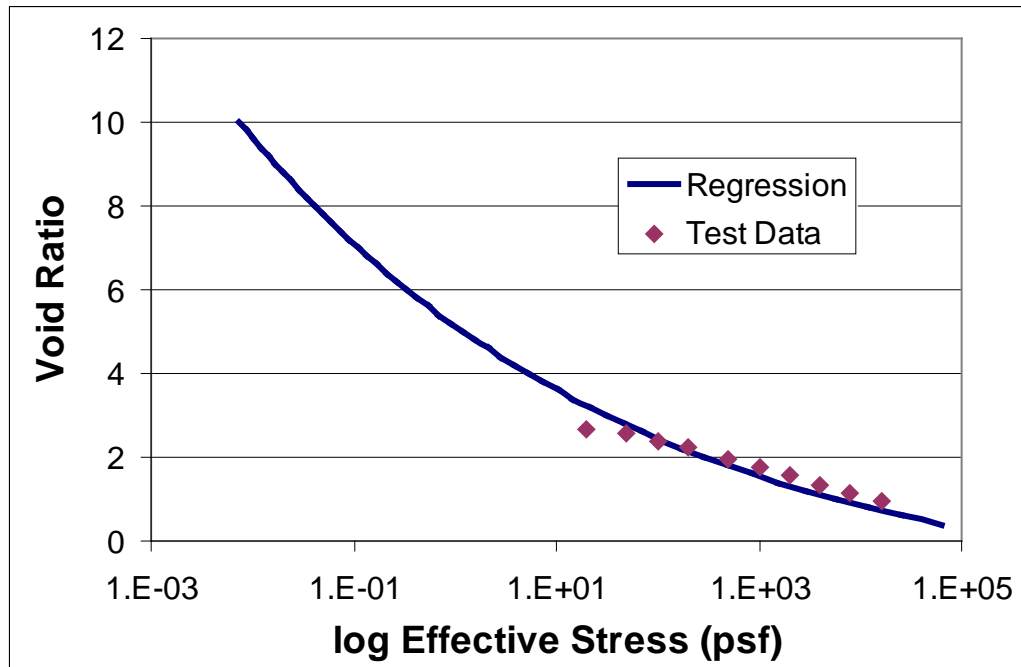


Figure 6. Void Ratio vs. Effective Stress and Void Ratio vs. Permeability Relationships for New Bedford Harbor Sediment Composite 1.

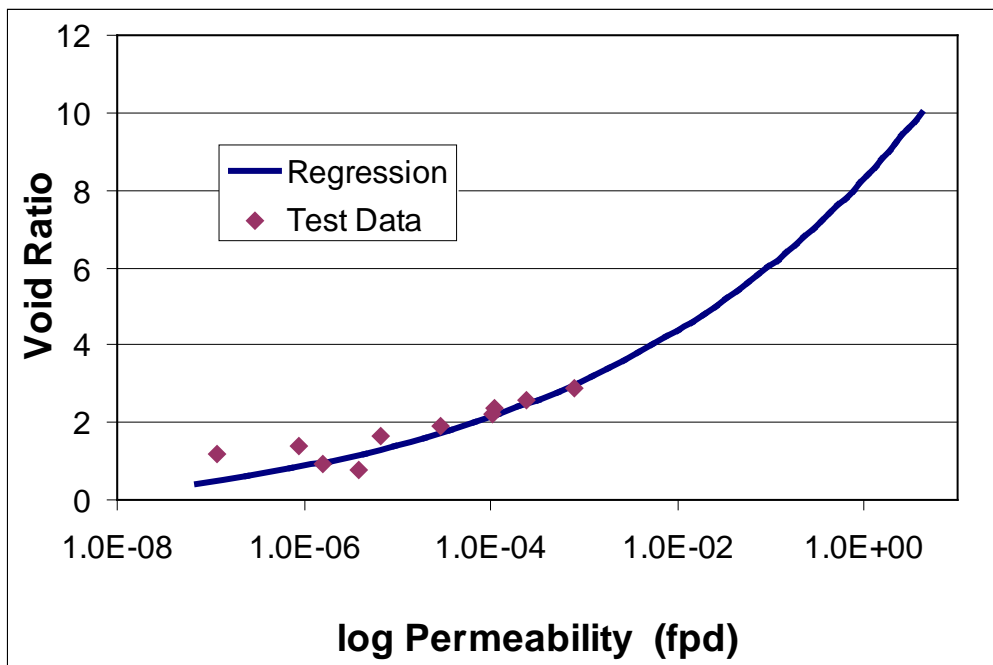
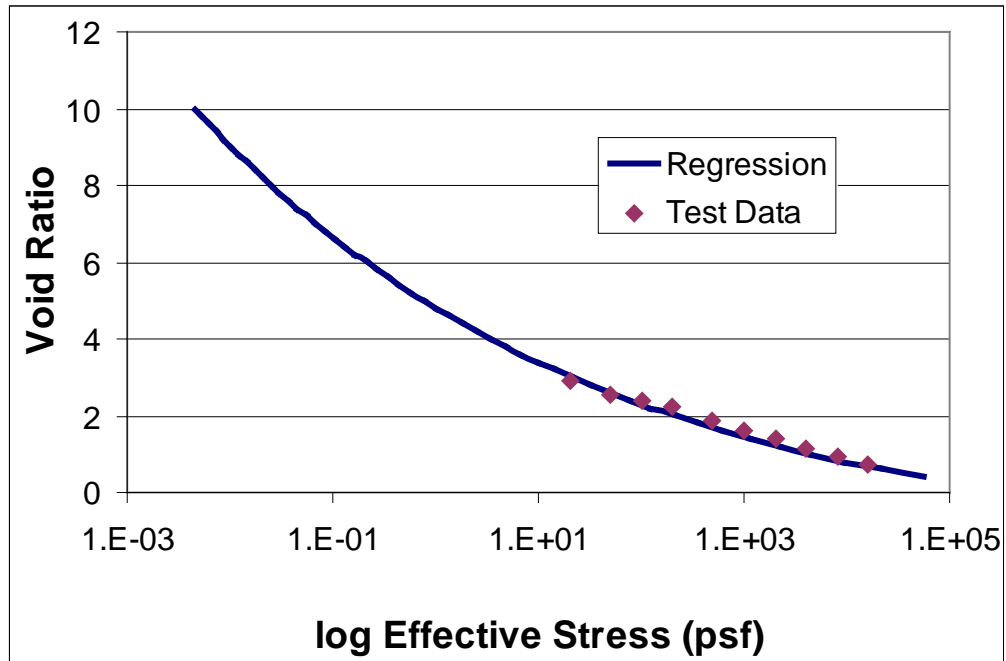


Figure 7. Void Ratio vs. Effective Stress and Void Ratio vs. Permeability Relationships for New Bedford Harbor Sediment Composite 2.

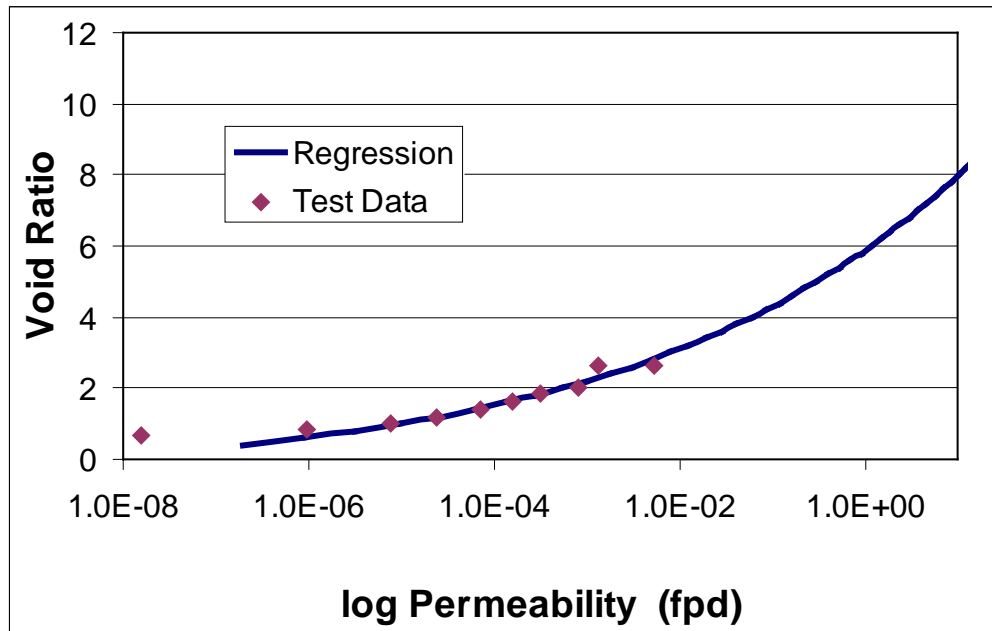
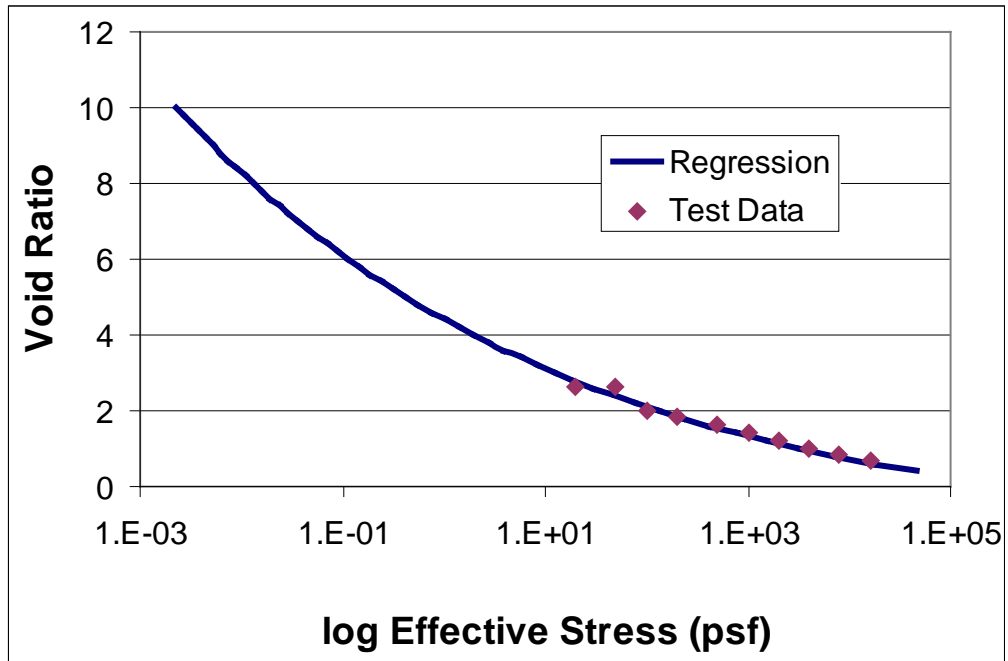


Figure 8. Void Ratio vs. Effective Stress and Void Ratio vs. Permeability Relationships for New Bedford Harbor Sediment Composite 3.

Table 1. Sediment Properties

| ID | Estimated tPCB (mg/kg)* | Mean tPCB (mg/kg) | Estimated Cu (mg/kg) | Mean Cu (mg/kg) | Estimated % S/C | Mean % S/C | Estimated TOC % | Mean TOC % |
|----------------|----------------------------|----------------------|-------------------------|--------------------|--------------------|---------------|--------------------|---------------|
| MU-1 | | | | | | | | |
| MU-102 (MF) | 1172 | | 598 | | 39.8 | | 7.7 | |
| MU-103 (MF) | 368 | | 881 | | 35.3 | | 9 | |
| MU-2 | | 770 | | 740 | | 38 | | 8 |
| MU-3 | 1691 | | | | | | | |
| MU-4 | | | | | | | | |
| MU-5 | 1940 | 1,816 | | | | | | |
| MU-6 | 347 | | 954 | | 65.6 | | 11.6 | |
| MU-7 | 2050 | 1,199 | 856 | 905 | 37 | 51 | 10.5 | 11 |
| MU-8 | | | | | | | | |
| MU-9 | 271 | | 701 | | 13.6 | | 6.2 | |
| MU-10 | 424 | 348 | 932 | 817 | | 14 | 7.1 | 7 |
| MU-11 | | | | | | | | |
| MU-12 | 199 | | 453 | | 5.6 | | 4.4 | |
| MU-13 | 147 | 173 | 1085 | 769 | 34.7 | 20 | 9.4 | 7 |
| MU-14 | 322 | | 1191 | | 46.7 | | 8.8 | |
| MU-15 | 322 | 322 | | 1,191 | | 47 | | 9 |
| MU-16 | 212 | | 941 | | 38.4 | | 7.8 | |
| MU-17 | 244 | 228 | | 941 | | 38 | | 8 |
| MU-18 | 238 | | 757 | | 33 | | 5.1 | |
| MU-19 | 182 | | | | | | | |
| MU-23 | 91 | 170 | 1199 | 978 | 53.3 | 43 | 10 | 8 |
| MU-104 (MF) | 91 | | | | | | | |
| MU-24 | 136 | | 1100 | | 58.8 | | 8.8 | |
| MU-20 | 166 | 131 | 1140 | 1,120 | 7.1 | 33 | 7.8 | 8 |
| MU-21 | 213 | | 1120 | | 2.5 | | 7.2 | |
| MU-22 | 133 | 173 | | 1,120 | | 3 | | 7 |

*Cells in gray were not calculated or data were unavailable

Table 2. Assumed Dredging and Placement Groupings for Upper Harbor CAD Cell

| Unit | Estimated Volume (cy) Remaining after 2012 | 10-Lift Groupings Volume (CY) | 5-Lift Groupings Volume (CY) |
|-------|--|-------------------------------|------------------------------|
| MU-1 | | | |
| MU-2 | | | |
| MU-3 | 16864 | | |
| MU-4 | 2091 | | |
| MU-5 | 8284 | 27,239 | |
| MU-6 | 27314 | 27,314 | |
| MU-7 | 29015 | | 83,568 |
| MU-8 | 11439 | 40,454 | |
| MU-9 | 10692 | | |
| MU-10 | 28942 | 39,634 | |
| MU-11 | 876 | | |
| MU-12 | 11884 | | 63,833 |
| MU-13 | 15024 | 27,784 | |
| MU-14 | 21099 | | |
| MU-15 | 24611 | 45,711 | 60,735 |
| MU-16 | 28155 | 28,155 | |
| MU-17 | 23750 | | |
| MU-18 | 18836 | 42,586 | 70,741 |
| MU-19 | 8571 | | |
| MU-20 | 11351 | | |
| MU-21 | 21250 | 41,172 | |
| MU-22 | 12536 | | |
| MU-23 | 5469 | | |
| MU-24 | 13750 | 31,755 | 72,927 |
| Sum | 351804 | 351804 | 351804 |